(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
2 May 2002 (02.05.2002)

PCT

(10) International Publication Number
WO 02/35879 A1

(51) International Patent Classification[7]: H04Q 7/38

(21) International Application Number: PCT/SE01/02179

(22) International Filing Date: 5 October 2001 (05.10.2001)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
0003921-4 24 October 2000 (24.10.2000) SE
0101207-9 3 April 2001 (03.04.2001) SE

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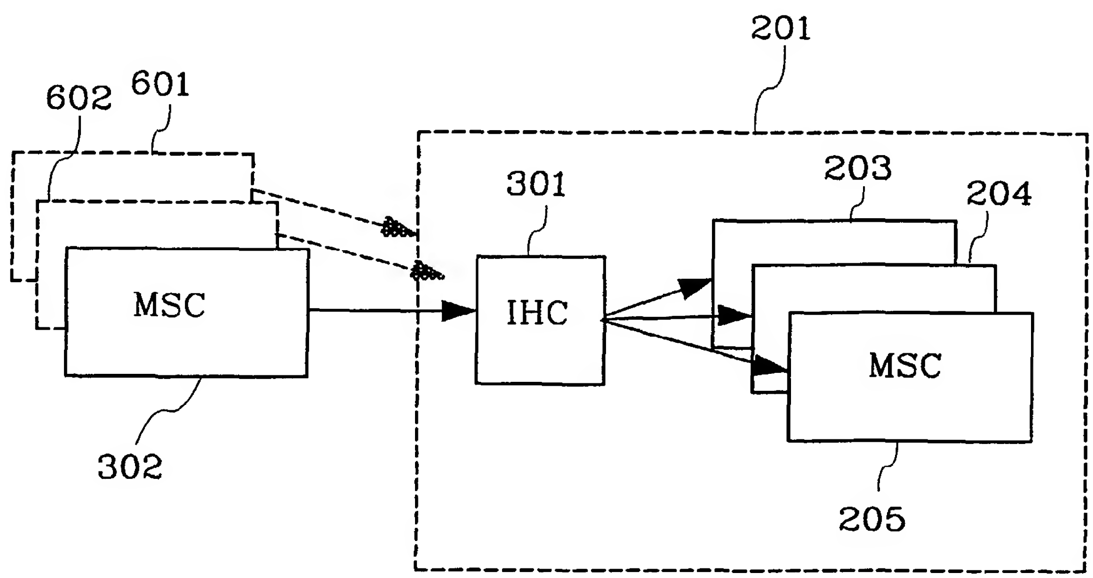
(81) Designated States (*national*): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PH, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

(84) Designated States (*regional*): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European

[Continued on next page]

(54) Title: METHOD AND MEANS FOR HANDOVERS IN A CELLULAR RADIO COMMUNICATION SYSTEM WITH AT LEAST ONE POOL OF CORE NETWORK NODES



(57) Abstract: The present invention relates to a method and means for handovers in a cellular radio communication system. An Incoming Handover Co-ordinator node (IHC) is arranged to control inter-MSC handovers to an MSC-pool (201) in the cellular radio communication system. The IHC (301) acts as an MSC towards MSC's (303, 601, 602) outside of the MSC-pool service area during handover control signalling. Target cell analyses, for inter-MSC handovers, in MSC's outside the MSC-pool will indicate the IHC (301) of the MSC-pool (201) instead of a specific MSC in the MSC-pool. The IHC will distribute the incoming handovers to selected MSC's within the pool according to an incoming handover distribution mechanism.

WO 02/35879 A1

patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

Method and means for handovers in a cellular radio communication system with at least one pool of core network nodes.

TECHNICAL FIELD OF THE INVENTION

The present invention relates in general to the field of cellular radio communication and, in particular, to a method and means for handovers in a cellular radio communication system with at least one pool of core network nodes.

DESCRIPTION OF RELATED ART

A cellular radio communication system is normally divided into an access network and a core network. The access network in GSM includes the Base Transceiver Stations (BTS) and control nodes such as the Base Station Controller (BSC) while the core network includes core network nodes such as the Mobile Switching Centre (MSC), the Visiting Location Register (VLR), the Home Location Register (HLR) and also the GPRS Support Node (GSN) if General Packet Radio Service (GPRS) is included in the system.

The next generation cellular radio communication system, i.e. the 3rd generation, is called IMT 2000 by ITU (the International Telecommunication Union) and includes the Universal Mobile Telecommunications System (UMTS). The access network in UMTS includes the base transceiver stations (Node B) and control nodes such as the Radio Network Controller (RNC) while the core network includes the same types of nodes as the GSM system (as described above).

Each control node in the access network (BSC or RNC) is connected to one specific MSC in known GSM and UMTS systems. This means that each control node always communicates with one dedicated MSC that serves a specific geographical area of the cellular system (i.e. an MSC Service Area). When a mobile station requests a service

from the cellular system it will be connected to the MSC of the current MSC Service Area by one of the control nodes. The mobile subscriber, that uses the mobile station, is registered in the VLR, that serves the MSC, the first time it is connected to the MSC. This means that the VLR receives subscriber information etc from the mobile station, the old VLR and/or the HLR. It is also possible to combine the VLR with an MSC into an MSC/VLR.

The mobile station will occasionally need to change MSC´s, from the MSC in the current MSC service area to a new MSC in a neighbouring MSC service area, due to the mobility of the mobile station and/or poor radio quality on the radio channel. The process of transferring the connection of the mobile station, during an active communication session (e.g. a voice call or a data transfer/call) from one MSC to another MSC is called inter-MSC handover, i.e. to switch MSC´s. A handover made between base stations in adjacent cells within the same MSC service area is called intra-MSC handover. The MSC to which a communication session from/to a mobile station is firstly established is called the controlling MSC. The mobile station remains registered in the VLR that belongs to the controlling MSC even after an handover to a new MSC, i.e. the registration is not changed due to an inter-MSC handover. The registration might be changed to a VLR that belongs to the new MSC after the communication session is ended, e.g. through a location update, if the mobile station remains to be powered on in the MSC service area of the new MSC after the communication session is ended. The MSC in the MSC service area where the communication session is currently being performed is called serving MSC and the specific MSC to which the inter-MSC handover is going to be made is called the target MSC.

A proposed new type of architecture for a cellular radio communication system is to create a pool of core network nodes, e.g. a pool of MSC's, that is connected to one or

more access networks, e.g. to control nodes, in the system. This means that each control node can access a number of MSC´s and that an MSC in a pool of MSC's can serve a mobile station in a larger geographical area than in a "normal" MSC service area, e.g. in a service area that covers a number of MSC service areas. This service area that is supported by a number of MSC´s is called MSC-pool service area. A pool of core network nodes is also called a CNN-pool and if it is a pool of MSC´s it is called an MSC-pool for simplicity. This new architecture will reduce the amount of inter MSC handovers and provide for an easy and smooth way to add (to increase capacity) or remove (e.g. for maintenance) MSC's or other core network nodes in the cellular system.

When a mobile station is having an active communication session while moving from an MSC service area (supported by a first MSC) to an MSC-Pool service area (supported by an MSC-pool), an inter-MSC handover to one of the MSC´s in the MSC-pool is needed.

In case of an inter-MSC handover in a GSM network that has no MSC-pool, the target cell analysis in the serving MSC is able to point out a single (new) MSC as a target MSC for the inter-MSC handover. This is because each cell belongs to an MSC service area that is supported by only one MSC.

In case of an inter-MSC handover to an MSC-pool, theoretically all of the MSC's in the pool are able to handle the incoming inter-MSC handover communication session and can therefore be addressed as the target MSC. This may lead to situations, where certain MSC´s in the pool are heavily loaded because of a number of incoming handovers, while other MSC's do not get any incoming handovers at all. Hence, there is a need for a method and means to control the distribution of the inter-MSC handovers coming into an MSC-pool.

By a mobile station is meant all portable equipment intended for radio communication, like mobile stations, transceivers, pagers, electronic notebooks, laptops with integrated radios, communicators, tailored microchips connected to radios or any other portable electronic equipment that is using a radio link as a mean of communication.

SUMMARY

The present invention meets a problem related to a cellular radio communication system, and particular to a cellular radio communication system where a pool of core network nodes (i.e. a CNN-pool) is arranged to serve at least one access network.

The problem is that handovers from core network nodes outside a CNN-pool to core network nodes inside the CNN-pool are lacking distribution control.

In light of the foregoing, a primary object of the present invention is to provide a method and means for controlling the distribution of handovers made from core network nodes outside the CNN-pool to core network nodes inside the CNN-pool.

Accordingly, the present invention provides a network node for controlling the distribution of handovers into the CNN-pool as claimed in claim 1.

The present invention also provides a core network node as claimed in claim 11.

A system for utilising a method, according to the present invention, is characterised as it appears from the appended claim 13.

The present invention further provides a method as claimed in claim 14.

Embodiments of the present invention are characterised as it appears from the sub-claims.

An advantage with the present invention is that the cellular radio communication system can distribute the load evenly between the core network nodes or direct the handovers to dedicated core network nodes in the CNN-pool.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is illustrating a view of a known GSM system.

Figure 2a is illustrating a view of a first cellular radio communication system with a pool of core network nodes.

Figure 2b is illustrating a view of a second cellular radio communication system with a pool of core network nodes.

Figure 3 is illustrating a view of a third cellular radio communication system with a pool of core network nodes.

Figure 4 is illustrating a flow chart of a first embodiment of the method according to the present invention.

Figure 5 is illustrating a flow chart of a second embodiment of the method according to the present invention.

Figure 6 is illustrating a simplified block diagram of an Incoming Handover Co-ordinator connected to a pool of core network nodes according to the present invention.

Figure 7 is illustrating a simplified block diagram of an Incoming Handover Co-ordinator according to the present invention.

DETAILED DESCRIPTION OF EMBODIMENTS

The present invention relates to a method and means for performing handovers in a cellular radio communication system.

Figure 1 illustrates a simplified view of a known GSM system 100. The GSM system 100 includes four Base Transceiver Stations (BTS) 101-104, which are serving one cell 105-108 each. BTS 101 and 102 are connected to a first Base Station Controller (BSC) 109, i.e. a first control node, and BTS 103 and 104 are connected to a second Base Station Controller (BSC) 110, i.e. a second control node. The first BSC is connected to a first MSC 111 and the second BSC 110 is connected to a second MSC 112. Cell 105 and 106 cover the MSC Service Area 116 of MSC 111 and cell 107 and 108 cover the MSC Service Area 117 of MSC 112. The BTS 101-104 and BSC 109-110 are access network nodes and part of the access network 114 and the MSC 111-112 are core network nodes and part of the core network 115. A Mobile Station 118 in communication with BTS 102 is also illustrated in cell 106. A connection has been established between the mobile station 118 and the first MSC 111 via BTS 102 and BSC 109. The MSC 111 and MSC 112 are connected to co-located VLR´s (i.e. as MSC/VLR´s) or stand alone VLR´s that are connected to a Home Location Register (HLR). The VLR´s and the HLR are not illustrated for simplicity.

According to the specification GSM TS 03.09 (for the GSM system), there are three different types of inter-MSC handovers: the basic handover (e.g. from MSC 111 to MSC 112); the subsequent handover (from MSC 112 back to the MSC 111); and also the subsequent handover from MSC 112 to another MSC, i.e. to a third MSC (not illustrated). The MSC 111 is the "controlling" MSC to which a communication session, from/to mobile station 118, is firstly established. Other MSC's, e.g. MSC 112, are "potential

target MSC's" in case of an inter-MSC handover during the communication session.

The word "call" will be used further on (e.g. a handover call or an active call), as an example of a communication session.

The handover process is similar for the 3rd generation mobile systems, e.g. for the inter-3G_MSC handovers in UMTS. The inter-3G_MSC handovers can be divided into basic and subsequent handovers, as in GSM, but also into handovers from a GSM system to a UMTS system, from an UMTS system to an GSM system and from a first UMTS system to a second UMTS system (also called a SRNS relocation procedure).

The basic handover from MSC 111 to 112, where the MSC 111 is the controlling MSC, starts when BSC 109, that controls the active call in the MSC service area 116, indicates to the MSC 111 that a handover needs to be performed to cell 107. The BSC 109 keeps track of neighbouring cells to cell 106 and makes its decision on handover on e.g. signal strength measurements from the mobile station 118 in known ways. The MSC 111 makes a target cell analysis, with the cell identity to cell 107 as an input, that points out MSC 112 as a target MSC for the handover.

This starts an inter-MSC handover as cell 107 is within another MSC service area than the serving cell 106, which means that there is a need to switch from MSC 111 to MSC 112. The MSC 111 will send a request to reserve resources for handover to the MSC 112, which is pointed out by the target cell analysis in MSC 111. The request carries the target cell identity (as input) which is used by the MSC 112 (in a target cell analysis) to find out (select) the BSC (the output) where the radio resources are to be reserved, i.e. BSC 110 in this case. When the resources have been reserved, the MSC 112 acknowledges to the MSC

111, which establishes a circuit connection between the MSC 111 and 112 (if needed) and orders the mobile station to the new radio channel in cell 107. The BSC 110 informs the MSC 112 and the MSC 112 informs the MSC 111 of the appearance of the mobile station on the new radio channel in cell 107. After the mobile station 118 has appeared on the new channel, the MSC 111 releases the previously used radio resources in BSC 109 and the connection between the MSC 111 and the BSC 109.

A Subsequent handover, i.e. from MSC 112 back to the MSC 111 (or to another MSC), starts, when BSC 110 that controls the active call for mobile station 118 in the MSC service area 117 indicates to the MSC 112 that a handover needs to be performed to a new cell (i.e. a target cell). The MSC 112 makes a target cell analysis, with the cell identity of the target cell as the input, that point out an MSC as a target MSC. The MSC 112 will send a request to reserve resources for handover to the MSC 111, i.e. the controlling MSC for the current call. The request is used by the MSC 111 to find out whether the target MSC identity (included in the request) is pointing to MSC 111, in which case it would be a subsequent handover back to MSC 111, or to a third (not illustrated) MSC, in which case it would be a subsequent handover to the third MSC.

In case of a subsequent handover back to MSC 111 the MSC 111 transmits an acknowledgement to the MSC 112 when the resources have been reserved. The mobile station is ordered to a new radio channel in cell 105 or 106. After the mobile station has appeared on the new channel, the MSC 111 informs MSC 112 that the previous handover call has ended while MSC 112 releases the radio resources in BSC 110.

In case of a subsequent handover to the third MSC, the MSC 111 (i.e. the controlling MSC for the current call) will send a request to reserve resources for handover to the

third MSC pointed out by the target cell analysis in MSC 112. The third MSC selects a BSC, reserves radio resources and acknowledges to the MSC 111, which establishes a circuit connection between the MSC 111 and the third MSC (if needed). The MSC 111 acknowledges to MSC 112, which orders the mobile station to the new radio channel in the service area of the third MSC. The third MSC informs the MSC 111 of the appearance of the mobile station on the new radio channel. After the mobile station has appeared on the new channel, the MSC 111 informs the MSC 112 that the previous handover call has ended and MSC 112 releases the radio resources in BSC 110.

Figure 2a illustrates a simplified view of an example of a cellular radio communication system 200 with an MSC-pool 201, connected to an access network 202. The MSC-pool 201 includes three MSC's 203-205 (that belongs to the core network). The three MSC's in the MSC-pool 201 are connected to three control nodes (Ctrl nodes) 206-208 in the access network 202. The control nodes 206-208 can, as an example, be Base Station Controllers in a GSM-system or Radio Network Controllers in an UMTS-system. The control nodes 206-208 are connected to a number of base stations 209-215, i.e. Base Transceiver Stations in a GSM system or Node B's in a UMTS system. Other parts of the access and core network are not illustrated in figure 2a for simplicity. The connection 217 between the MSC's 203-205 and the control nodes 206-208 may be arranged by dedicated circuits as illustrated in figure 2a or by a packet network 218, e.g. an IP network, as illustrated in figure 2b. All control nodes 206-208 in the access network 202 can access any one of the MSC's 203-205 in the MSC-pool 201 and vice versa. A mobile station 216, which communicates with the control node 207 via base station 213, is also illustrated in figure 2a.

An Incoming Handover Co-ordinator node (IHC) is introduced to control the distribution of handovers from MSC's outside

an MSC-pool to MSC's in the MSC-pool. The IHC is dedicated for one (or more) MSC-pool(s) and acts as an MSC towards the MSC's outside of the MSC-Pool service area for the handover control signalling. The IHC will not be involved in any possible communication path establishment/release between the MSC's, e.g. the establishment of a circuit connection, for speech or user data. The IHC will only be involved in the handover control signalling according to the embodiments described below. A target cell analysis for handover in MSC's outside the MSC-pool will not indicate any target MSC within the MSC-Pool, but instead indicate the IHC of the MSC-Pool. Ordinary Operations and Maintenance (O&M) commands in the MSC's are used to introduce the IHC in the target cell analysis.

By target cell analysis is meant an analysis that uses a cell identity as input, and generates a BSC identity or an MSC identity as output. An MSC can make a target cell analysis on a target cell identity that results in a target MSC identity that points out a target MSC (for inter-MSC handovers) or a target BSC identity that points out a target BSC in the same MSC service area (for intra-MSC handovers) or in the same MSC-pool service area (during an inter-MSC handover into the pool, see e.g. step 406). An MSC can also make a target MSC analysis on a target MSC identity to check if the MSC is the target MSC or not, especially during subsequent handovers.

Figure 3 illustrates a simplified view of a cellular radio communication system 300 with the MSC-pool 201, as illustrated in figure 2a, plus an IHC 301 (in the MSC-pool 201), two single MSC´s 302-303 outside the MSC-pool 201, two control nodes 304-305 and four base stations 306-309. The base stations 209-211 and 214-215 in figure 2a are omitted in figure 3 for simplicity. The base stations 306-307 are connected to the control node 304, which is connected to MSC 302. The MSC 302 supports an MSC service area 310 that

includes the cells 311 and 312. Base station 306 supports cell 311 and base station 307 supports cell 312. The MSC 302 is connected to the MSC's in the MSC-pool 201 via the IHC 301. The IHC 301 can be arranged in the MSC-pool 201 (as in figure 3), outside the MSC-pool or even be integrated with one or more nodes in the system, e.g. in the MSC's in the MSC-pool 201. The base stations 308-309 are connected to the control node 305, which is connected to MSC 303. The MSC 303 supports an MSC service area 317 that includes the cells 318 and 319. Base station 308 supports cell 318 and base station 309 supports cell 319. A mobile station 313 is communicating with base station 307 in cell 312. The MSC-pool service area 314, that is supported by the MSC-pool 201, and the cells that base stations 212 and 213 are supporting inside the MSC-pool service area 314 are also illustrated in figure 3. Base station 212 supports cell 315 and base station 213 supports cell 316. The rest of the cells, base stations, connections etc. within the MSC-pool service area 314 and other parts of the system 300 are not illustrated in figure 3 for simplicity.

Figure 4 illustrates a flowchart of a first embodiment of the method according to the present invention. The method is applied in the system that is illustrated in figure 3. This means that there will be references to figure 3 as well as to figure 4. The mobile station 313 moves, during an active call, from MSC service area 310 to the MSC-Pool service area 314 (an arrow illustrates the direction of the movement in figure 3). The call was originally established via MSC 302, which is the controlling MSC as well as the serving MSC for the current call. Hence, an inter-MSC handover from MSC 302 to MSC-pool 201 is a basic handover.

According to a step 401 in figure 4, the control node 304 (the control node for the active call in the MSC service area 310) indicates to the MSC 302 that a handover needs to be made to cell 316, e.g. due to a poor radio quality. Cell

316, i.e. the target cell, is identified by the control node 304.

According to a step 402, the MSC 302 selects a target MSC for the inter-MSC handover. The selection is made as a result of a target cell analysis in the MSC 302. In this case, the target cell analysis indicates that the target cell 316 is situated in the MSC-pool service area 314, served by the MSC-pool 201 that includes the IHC 301. The IHC 301 is selected as the target MSC for the handover. A basic handover from an "outside" MSC into the MSC-pool is always made to the IHC.

According to a step 403, the MSC 302 transmits a Request to Reserve Radio Resources (RtRRR) for handover to the IHC 301. The request includes the target cell identity of cell 316.

According to a step 404, the IHC 301 selects one of the MSC's in the pool 201 as the target MSC for the handover according to an incoming handover distribution mechanism. Any one of the MSC's in the MSC-pool can be selected as all MSC's in the MSC-pool 201 have access to all control nodes within the MSC-pool service area 314. This also means that any one of the MSC's in the MSC-pool can support the current call when the mobile station is moved into the target cell 316. The incoming handover distribution mechanism is described further on.

According to a step 405, the IHC 301 forwards the RtRRR for handover to the selected MSC, in this case MSC 205.

According to a step 406, the MSC 205 orders the control node that controls the base station that supports cell 316, i.e. control node 207 in this case, to reserve radio resources for the mobile station 313 in cell 316. The MSC 205 uses a target cell analysis based on the target cell identity in

the RtRRR to find the right control node, i.e. control node 207.

According to a step 407, the control node 207 transmits an acknowledgement (Ack) to the MSC 302 via MSC 205 and IHC 301 when the radio resources have been reserved. A communication path (that bypasses the IHC) is established between the MSC 302 and MSC 205 if needed (not illustrated in figure 3) and is kept as long as MSC 205 is involved in the call. The communication path is needed for e.g. speech transmissions but not for pure signalling connections, e.g. SMS transfers. The communication path can as an example be a circuit connection but different packet transfer techniques may also be used for establishing such a communication path.

According to a step 408, the MSC 302 orders the mobile station 313 to change the radio channel in cell 312 to the new radio channel in cell 316.

According to a step 409, the MSC 205 informs the MSC 302 via IHC 301 when the mobile station 313 is on the new channel in cell 316 (MSnewC). Old radio resources (in cell 312) and the connection between MSC 302 and control node 304 are released. The basic handover is now completed.

When the handover call ends (e.g. because of termination of the call or because of a subsequent handover), the MSC 302, i.e. the controlling MSC of the active call, informs the MSC 205 via IHC 301 that the handover call has ended (HOend). Radio resources and the connection between control node 207 and MSC 205 and the communication path (if any) between the MSC 205 and MSC 302 are released.

A subsequent inter-MSC handover from MSC 205 back to the MSC 302 is performed if the mobile station 313 changes direction, during the active call, and moves from the MSC-pool service area 314 back to the MSC service area 310.

This subsequent inter-MSC handover from the MSC-pool 201 is performed as usual (according to well-known techniques) but with one major difference in that the handover control signalling is sent via the IHC 301. This is because the IHC was involved in the previous handover (i.e. the basic handover) from the controlling MSC 302 to the current MSC 205. By handover control signalling is meant the signalling that controls the handover. This is currently made with MAP signalling as described below.

Examples of such control signals are the RtRRR, acknowledgements (in steps 407 and 509), MsnewC (in steps 409 and 511) and Hoend. Note that a basic handover from the MSC-pool 201 is performed without the use of the IHC 301. Figure 5 illustrates a flowchart of a second embodiment of the method according to the present invention. The method is applied in the system that is illustrated in figure 3. This means that there will be references to figure 3 as well as figure 5. The mobile station 313 is moved, during an active call, from MSC service area 317 to the MSC service area 310 and then to MSC-pool service area 314. The call is originally established via MSC 303, which means that MSC 303 is the controlling MSC for the current call. A basic handover from MSC 303 to MSC 302 has been performed and a subsequent (inter-MSC) handover from MSC 302 (i.e. the serving MSC) to the MSC-pool 201 is to be performed.

According to a step 501 in figure 5, the control node 304 indicates to the MSC 302 that a handover needs to be made to cell 316 (as in step 401).

According to a step 502, the MSC 302 selects the IHC 301 as target MSC for the inter-MSC handover (as in step 402).

According to a step 503, the MSC 302 transmits the request to reserve resources (RtRRR) for handover to the controlling MSC 303. The request includes the target MSC

identity of the IHC 301 and the target cell identity from control node 304.

According to a step 504, the MSC 303 makes a target MSC analysis on the target MSC identity that indicates the IHC 301, received from the MSC 302. As the target MSC identity indicates the IHC 301, the MSC 303 realises that a subsequent handover to the MSC-pool 201 is to be performed.

According to a step 505, the MSC 303 forwards the RtRRR, that was received from the MSC 302, to the IHC 301.

According to a step 506, the IHC 301 selects one of the MSC's in the pool 201 as the target MSC for the handover according to the incoming handover distribution mechanism (as in step 404).

According to a step 507, the IHC 301 forwards the RtRRR for handover to the selected target MSC (in this case MSC 205).

According to a step 508, the MSC 205 orders the control node 207 to reserve radio resources for the mobile station 313 in cell 316 (as in step 406).

According to a step 509, the control node 207 transmits an acknowledgement to the controlling MSC 303 via MSC 205 and IHC 301 when the radio resources have been reserved. A communication path (that bypasses the IHC) is established between the controlling MSC 303 and MSC 205 if needed (not illustrated in figure 3) and is kept as long as MSC 205 is involved in the call.

According to a step 510, the controlling MSC 303 transmits an acknowledgement (ack) to the serving MSC. The serving MSC orders the mobile station 313 to change the radio channel in cell 312 to the new radio channel in cell 316.

According to a step 511, the MSC 205 informs the MSC 303 via IHC 301 when the mobile station 313 is on the new channel in cell 316 (as in step 409). The MSC 205 is now the serving MSC.

According to a step 512, the controlling MSC 303 informs the previous serving MSC 302 that the handover call to the MSC 302 has ended. Old radio resources (in cell 312) and the communication path (if there is any) between MSC 302 and 303 are released.

When the handover call ends (e.g. because of termination of the call or because of a subsequent handover), the MSC 303, i.e. the controlling MSC of the active call, informs the MSC 205 via IHC 301 that the handover call has ended. Radio resources and the connection between control node 207 and MSC 205 and the communication path (if there is any) between the MSC 205 and MSC 303 are released.

There is a traffic case where a subsequent handover from the MSC 302 to the MSC-pool 201 does not involve the IHC 301. This is the case when the call has been originally established via MSC 205 in the MSC-pool 201 and a basic handover from the MSC-pool 201 to MSC 302 has been performed. This means that MSC 302 is the serving MSC and MSC 205 in the MSC-pool is the controlling MSC when this subsequent handover is to be performed. As there is an up and running communication path between the MSC 205 and the MSC 302, which was established during the basic handover, there is no need to involve the IHC 301 in any selection of MSC´s in the pool. The MSC 302 selects the IHC 301 as the target MSC for the inter-MSC handover in its target cell analysis as usual, but the serving MSC 302 can transmit the request to reserve resources (RtRRR) for handover directly to the controlling MSC 205, i.e. not via the IHC. The MSC 205 will realise that a subsequent handover back to the MSC 205 is to be performed (and not a subsequent handover to a

third MSC as in the second embodiment above) when it makes the target MSC analysis on the target MSC identity and notice that the IHC 301 is indicated as the target MSC.

As previously stated, an incoming handover distribution mechanism is used by the IHC for selecting a suitable MSC in the MSC-pool during an inter-MSC handover into the MSC-pool. Many possible selection criteria can be used separately or in a combination, e.g. to select one of the MSC´s in the MSC-pool randomly, or select one according to a pre-defined selection schedule, or select one according to its load or according to its availability. The core network node addresses are used to address the selected MSC.

Figure 6 illustrates a simplified block diagram of how the IHC 301 can be arranged between MSC's in an MSC-pool, e.g. MSC-pool 201, and an "external" (single) MSC, e.g. MSC 302. More than one external MSC can be connected to the IHC 301 as illustrated by the dashed blocks 601 and 602. The IHC can be a stand-alone node in the MSC-Pool, as illustrated in figure 6, or integrated with an MSC in the MSC-Pool 201 or integrated with any other suitable node in the system. Hence, the IHC is a network node that can be arranged as a core network node in the core network. An IHC can also be arranged to handle inter-MSC handovers to more than one MSC-Pool (if there is enough capacity in the IHC). In this case the IHC would need to have a target cell analysis to select the target MSC-pool before selecting the target MSC in the target MSC-pool. Note that the IHC needs, in this case, to handle even the inter-MSC handovers between the MSC-Pools, it is controlling. There can also be several IHC´s in one MSC-Pool, where each IHC co-operates with different external MSC's. In this case each IHC can handle inter-MSC handovers to all of the MSC's in the MSC-Pool or to a separate set of the MSC´s in the MSC-pool.

The IHC 301 is involved in the handover control signalling according to the above-described embodiments. The IHC 301 receives and forwards the requests to reserve resources (RtRRR) for inter-MSC handover in the MSC-Pool. In GSM (and probably in UMTS networks) the handover control signalling is realised with MAP-signalling over TCAP (MAP = Mobile Application Part, TCAP = Transaction Capabilities Application Part).

A TCAP-dialogue is maintained for the whole handover call until the handover call is ended, e.g. because the actual call is ended or because of a subsequent handover to another MSC. The IHC 301 will break the TCAP-dialogue between the MSC outside the MSC pool, e.g. MSC 302, and the MSC inside the MSC-pool, e.g. MSC 205, into two TCAP-dialogues: one between MSC 302 and the IHC and one between the IHC and the MSC 205.

Figure 7 illustrates a simplified block diagram of an example of an Incoming Handover Co-ordinator node (IHC) for utilising the inventive embodiments above. The IHC includes a Handover Distributor unit 701 (HD-unit) that is arranged to serve a Dialogue Co-ordinator unit 702 (DC-unit). The DC-unit 702 is arranged to communicate with a first and a second Dialogue Handler unit 703-704 (DH-unit) respectively. The first and second Dialogue Handler units are arranged to communicate with one or more MSC´s and/or one or more MSC-pool´s.

The HD-unit 701 is responsible for selecting a suitable MSC in the MSC-pool for the handovers into the MSC-pool, i.e. to perform the incoming handover distribution mechanism. The HD-unit 701 may select the MSC´s in such a way that it distributes the handovers evenly between the MSC’s or base the selection on one or a combination of the following distribution parameters:

- pre-defined handover ratios between the MSC's;
- the availability of the MSC's;
- the current load situation in the MSC's;
- the target cell;
- the originator of the request (i.e. MSC 302).

The HD-unit 701 may also distribute the handovers to certain MSC's which are dedicated for incoming handover calls in the MSC-pool. The availability parameter of the MSC's can as an example be based on the success of the most recent resource reservations from the MSC's made via the IHC. As an alternative there can be a mechanism for the MSC´s in the MSC-Pool to report their availability/ unavailability for incoming handover calls to the IHC 301 (or IHC´s if more than one). The estimation of the current load in the MSC´s can in general be based on processor utilisation over a time interval, queue lengths (in e.g. signalling buffers and job execution buffers), pending work (such as calls in progress or during establishment or clearing), and to combinations of these. More specific examples are the number of ongoing handover transactions per MSC or the occupancy count of the corresponding VLR´s. The reporting may be a stand-alone process (e.g. as a background process) or be connected to the resource reservation acknowledgements, e.g. as a new parameter. The HD-unit 701 may also co-operate with another network node in the system that control or determines the load in the MSC´s etc. The incoming handover distribution mechanism can be fixed or dynamic (i.e. change its distribution parameter or parameters when needed).

The DC-unit 702 is arranged to co-ordinate the work between the HD-unit 701 and each DH-unit in the IHC 301. The number of DH-units can vary depending on how the IHC is implemented in the cellular system. The DC-unit functions

as an adapter between the DH-units (see below). The DC-unit can be omitted in some implementations if its function is implemented in, e.g. the DH-units.

The DH-units handle the communication, i.e. the dialogue, between the IHC and one or more external MSC's, as the DH-unit 703, and/or between the IHC and one or more MSC's in one or more MSC-pools, as the DH-unit 704.

The invention can be completely or partially implemented as software in at least one microprocessor.

CLAIMS

1. A network node in a radio communication system, where said system includes at least two core network nodes (203-205) that are arranged in a first pool of core network nodes (201) that supports mobile stations in a first service area (314), and where said system also includes a third core network node (302,303,601-602) that supports mobile stations in at least a part of a second service area (310,317),

c h a r a c t e r i s e d in that said network node (301) is arranged to communicate with said at least two core network nodes (203-205) in said first pool and with said third core network node (302,303,601-602), and where said network node (301) includes means for controlling (701-704) the distribution of handovers from said third core network node (302,303,601-602) to said at least two core network nodes (203-205) in said first pool (201).

2. The network node as claimed in claim 1, wherein said means for controlling the distribution of handovers includes means for selecting (701) a target core network node in said first pool (201) for each one of said handovers.

3. The network node as claimed in claim 1 or 2, wherein said means for controlling the distribution of handovers includes first means for communicating (703) with said at least two core network nodes in said first pool (201) and second means for communicating (704) with said third core network node.

4. The network node as claimed in claim 3, wherein said means for controlling the distribution of handovers includes means for co-ordinating (702) the work between said means for selecting (701) and said first and second means for communicating (703,704).

5. The network node as claimed in one of claims 2-4, wherein said means for selecting (701) is arranged to use a pre-determined handover distribution mechanism to select said target core network node.

6. The network node as claimed in one of claims 1-5, wherein said third core network node (302,303,601,602) is arranged in a second pool of core network nodes together with at least a fourth core network node, and where said means for controlling the distribution (701-704) of handovers is arranged to control the distribution of handovers from said core network nodes in said first pool (201) to said core network nodes in said second pool and vice versa.

7. The network node as claimed in one of claims 1-5, wherein said means for controlling the distribution (701-704) of handovers to said core network nodes (203-205) in said first pool (201) is also arranged to control the distribution of handovers from said third core network node (302,303,601-602) to at least a third pool of core network nodes in said system.

8. The network node as claimed in claim 7, wherein said means for controlling the distribution (701-704) of handovers is further arranged to control the distribution of handovers between said third and first pool (201).

9. The network node as claimed in one of claims 1-8, wherein said network node (301) is arranged in said first pool (201).

10. The network node as claimed in one of claims 1-9, wherein said core network nodes (203-205,302,303,601-602) with which said network node is arranged to communicate with are MSC´s.

11. A core network node c h a r a c t e r i s e d in that said core network node includes at least a first network node (301) as claimed in one of claims 1 to 10 and at least a first MSC.

12. The core network node as claimed in claim 11, wherein said first network node (301) is arranged to co-operate with at least a second similar network node arranged together with a second MSC.

13. A radio communication system c h a r a c t e r i s e d in that said system includes at least one network node (301) as claimed in one of claims 1 to 10.

14. A method for performing handovers from a first core network node (302,303,601,602) to at least a first pool of core network nodes (201) in a radio communication system, where said first pool of core network nodes supports mobile stations in a first service area (314) and said first core network node supports mobile stations in at least a part of a second service area (310,317),

c h a r a c t e r i s e d in that said first core network node (302,303,601,602) selects (402,502) a pre-determined network node (301) in said radio communication system as a first target core network node for said handovers, and where said pre-determined network node (301) distributes (404-405, 506-507) said handovers to core network nodes (203-205) in said first pool of core network nodes (201).

15. The method as claimed in claim 14, wherein said network node distributes said handovers by selecting (404,506) a target core network node in said first pool of core network nodes (201) for each one of said handovers.

16. The method as claimed in claim 14 or 15, wherein the handover control signalling between said first core network node (302,303,601,602) and said first pool of core network nodes (201) is sent via said network node (301).

17. The method as claimed in one of claims 14-16, wherein said first core network node (302,303,601,602) is arranged in a second pool of core network nodes that supports mobile stations in said second service area.

18. The method as claimed in one of claims 14-17, wherein said network node (301) selects (404,506) said target core network nodes with the help of random decisions, a pre-defined selection schedule, the load or the availability of each core network node in said at least first pool (201).

19. The method as claimed in claim 14, wherein said pre-determined network node (301) distributes (404-405, 506-507) said handovers to core network nodes in at least a third pool of core network nodes as well as to said core network nodes (203-205) in said first pool (201).

20. The method as claimed in claim 19, wherein said network node selects a target pool before selecting (404,506) a target core network node in said selected target pool for each one of said handovers.

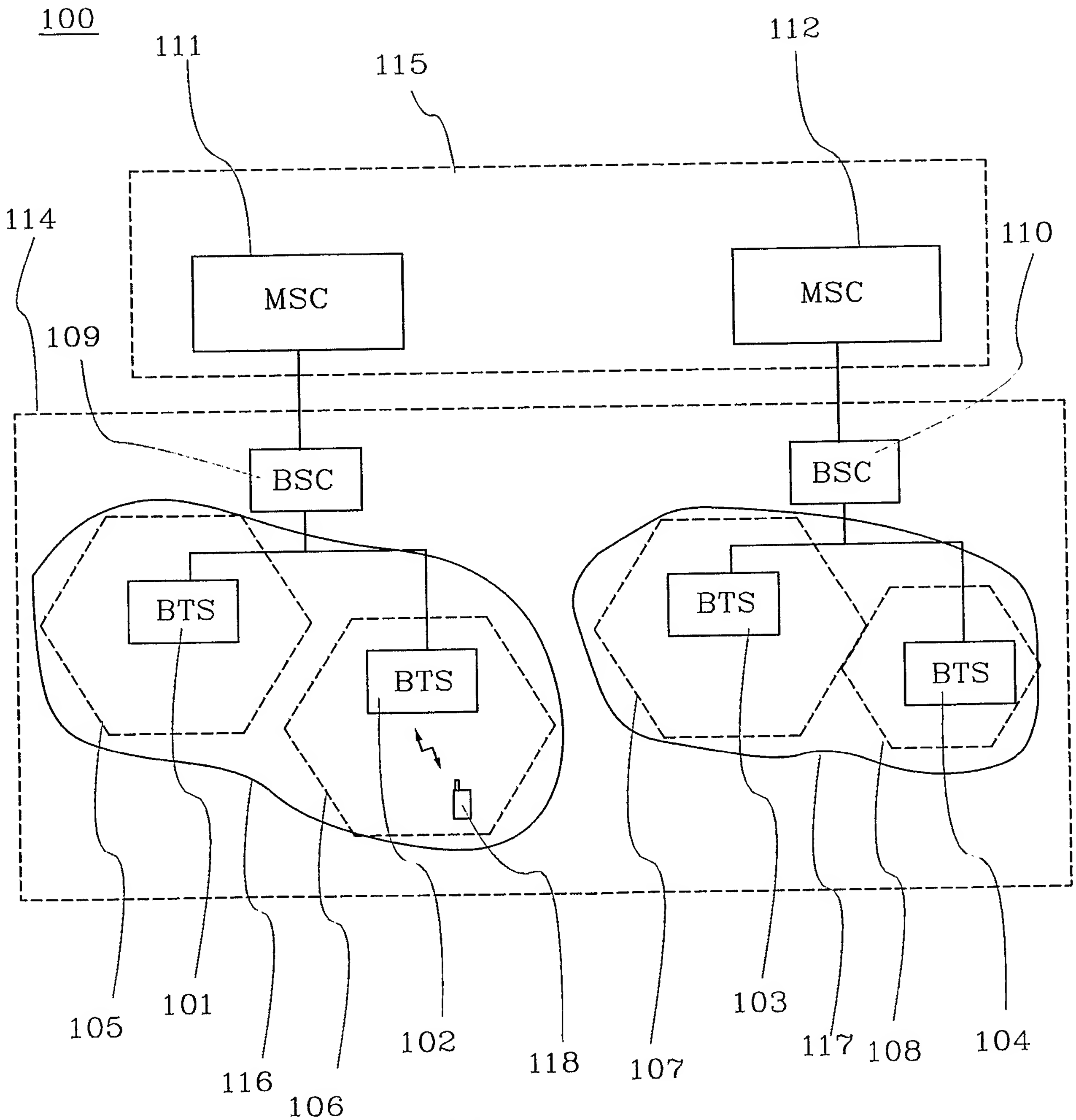

100
111
115
112
114
110
109
MSC
MSC
BSC
BSC
BTS
BTS
BTS
BTS
105
101
116
106
102
118
107
103
117
108
104

Fig. 1

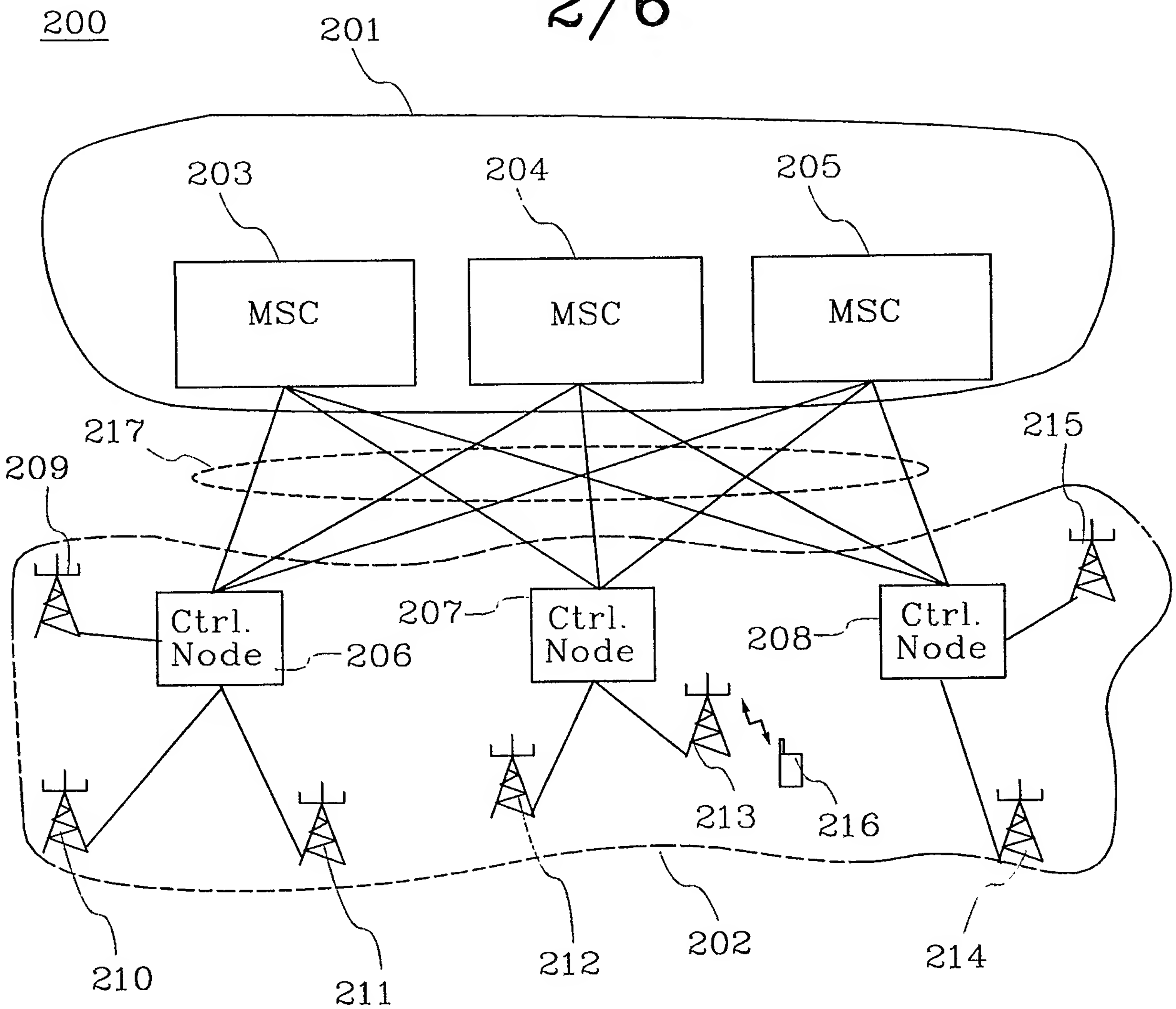

200
201
203
204
205
MSC
MSC
MSC
217
209
215
Ctrl. Node
206
207
Ctrl. Node
208
Ctrl. Node
213
216
210
211
212
202
214

Fig. 2a

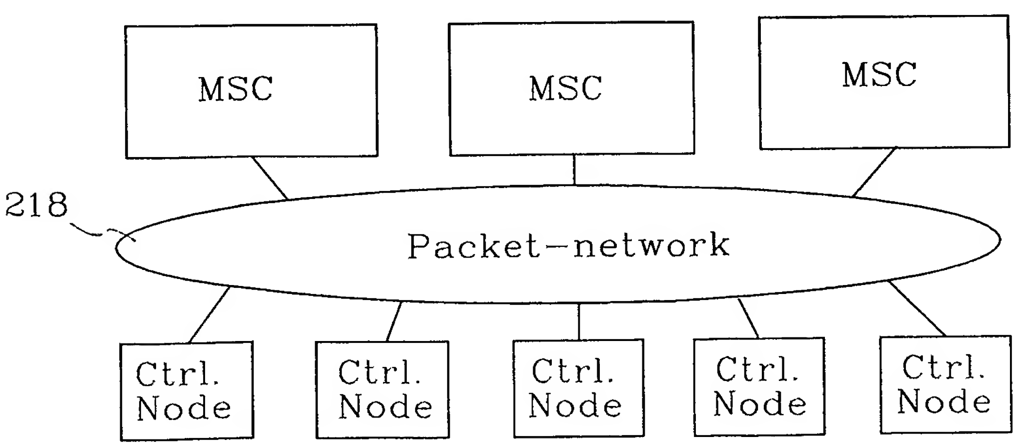

MSC
MSC
MSC
218
Packet-network
Ctrl. Node
Ctrl. Node
Ctrl. Node
Ctrl. Node
Ctrl. Node

Fig. 2b

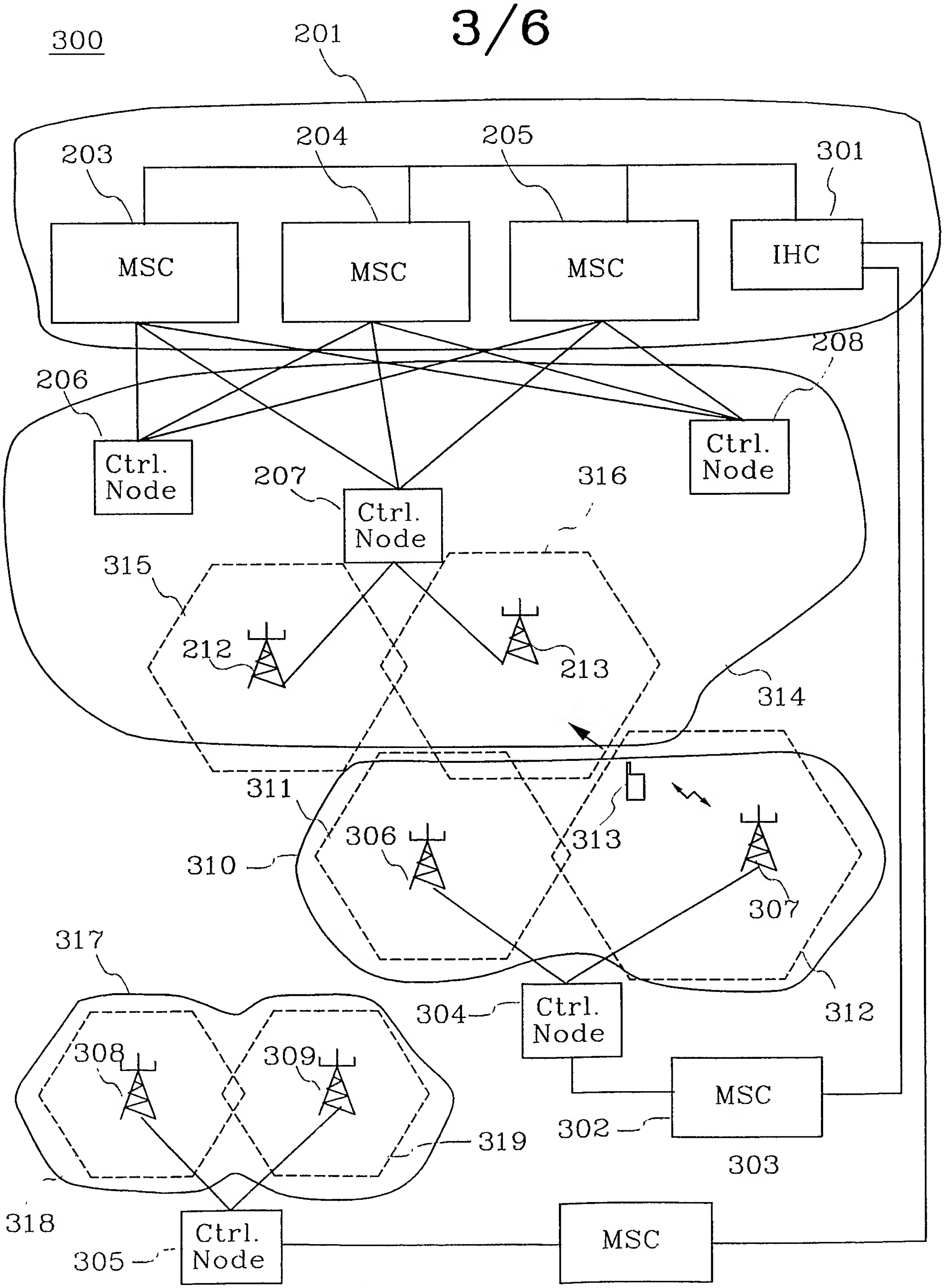

300
201
203
204
205
301
MSC
MSC
MSC
IHC
208
206
Ctrl. Node
207
Ctrl. Node
316
Ctrl. Node
315
212
213
314
311
306
313
310
307
317
304
Ctrl. Node
312
308
309
MSC
319
302
303
318
Ctrl. Node
MSC
305

Fig. 3

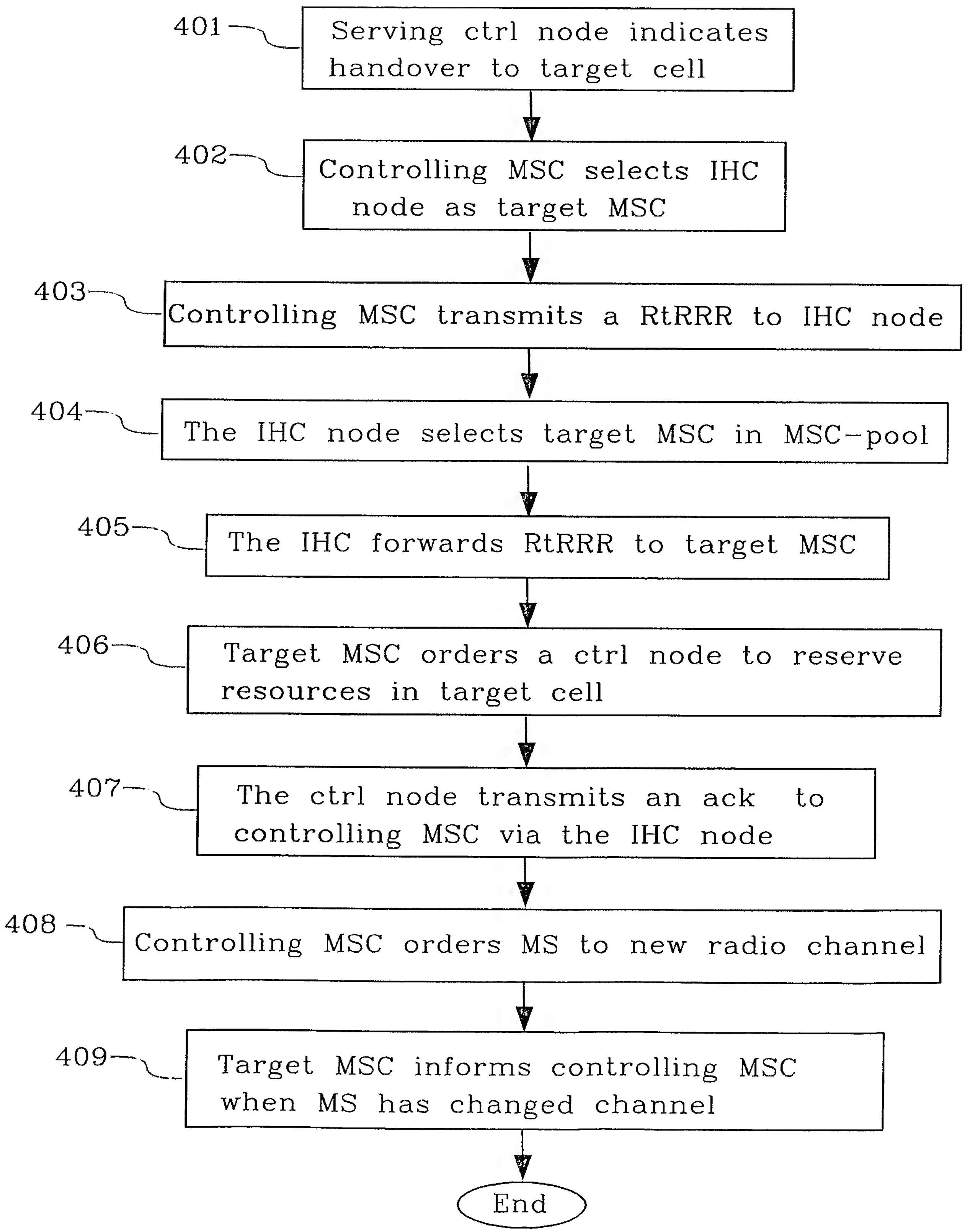

401
Serving ctrl node indicates handover to target cell
402
Controlling MSC selects IHC node as target MSC
403
Controlling MSC transmits a RtRRR to IHC node
404
The IHC node selects target MSC in MSC–pool
405
The IHC forwards RtRRR to target MSC
406
Target MSC orders a ctrl node to reserve resources in target cell
407
The ctrl node transmits an ack to controlling MSC via the IHC node
408
Controlling MSC orders MS to new radio channel
409
Target MSC informs controlling MSC when MS has changed channel
End

Fig. 4

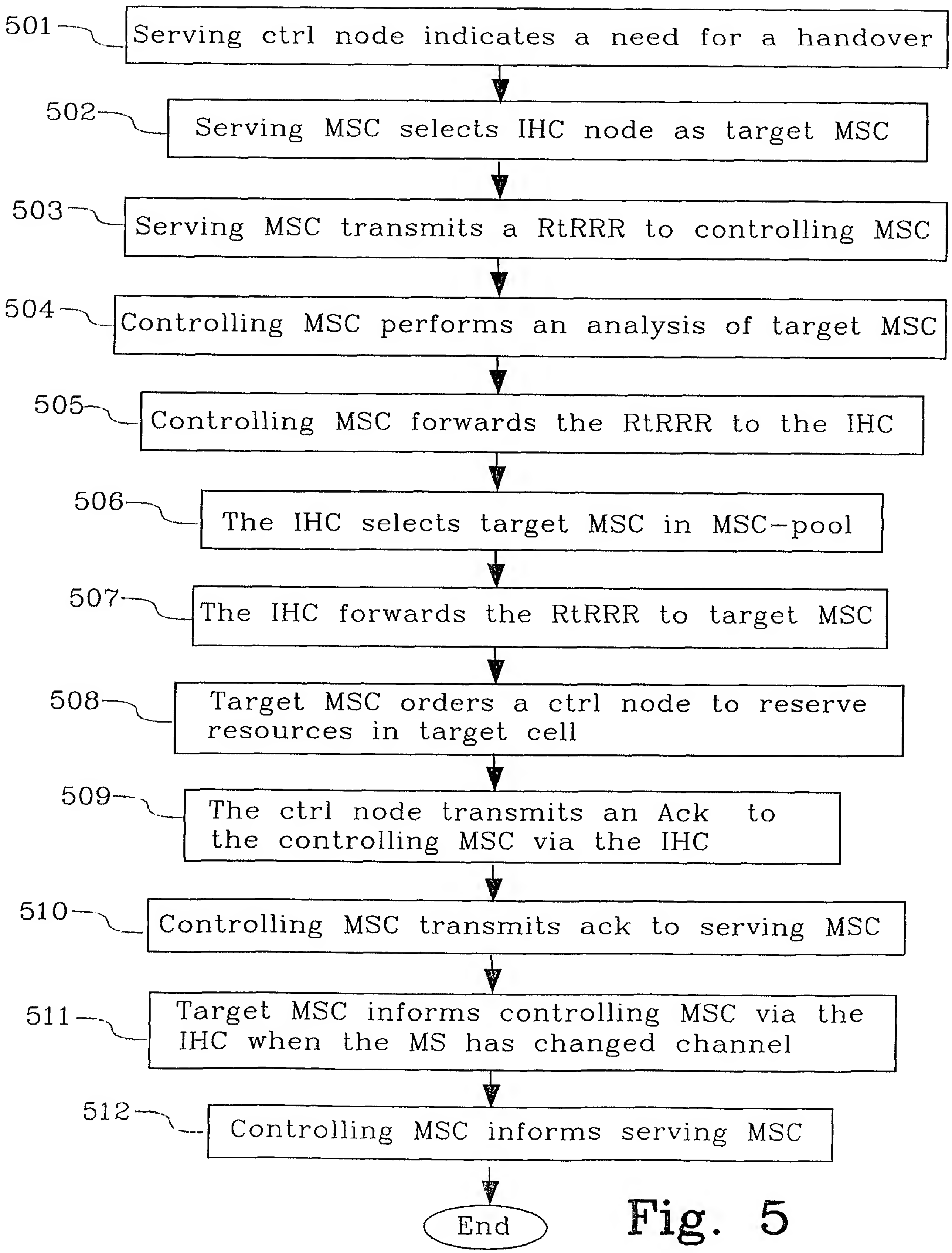

501
Serving ctrl node indicates a need for a handover
502
Serving MSC selects IHC node as target MSC
503
Serving MSC transmits a RtRRR to controlling MSC
504
Controlling MSC performs an analysis of target MSC
505
Controlling MSC forwards the RtRRR to the IHC
506
The IHC selects target MSC in MSC-pool
507
The IHC forwards the RtRRR to target MSC
508
Target MSC orders a ctrl node to reserve resources in target cell
509
The ctrl node transmits an Ack to the controlling MSC via the IHC
510
Controlling MSC transmits ack to serving MSC
511
Target MSC informs controlling MSC via the IHC when the MS has changed channel
512
Controlling MSC informs serving MSC
End

Fig. 5

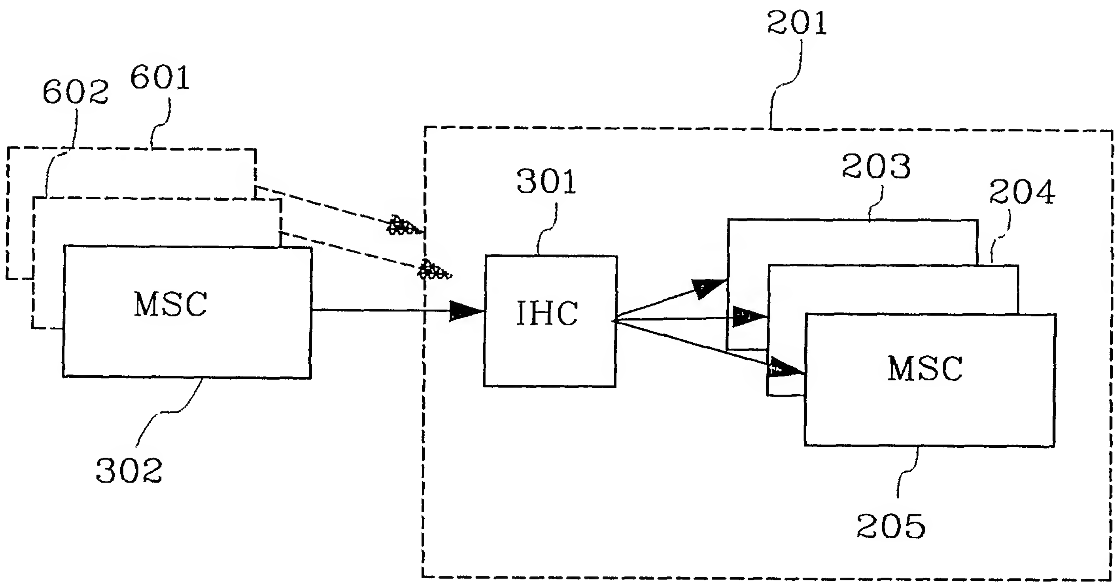

201
602
601
301
203
204
MSC
IHC
MSC
302
205

Fig. 6

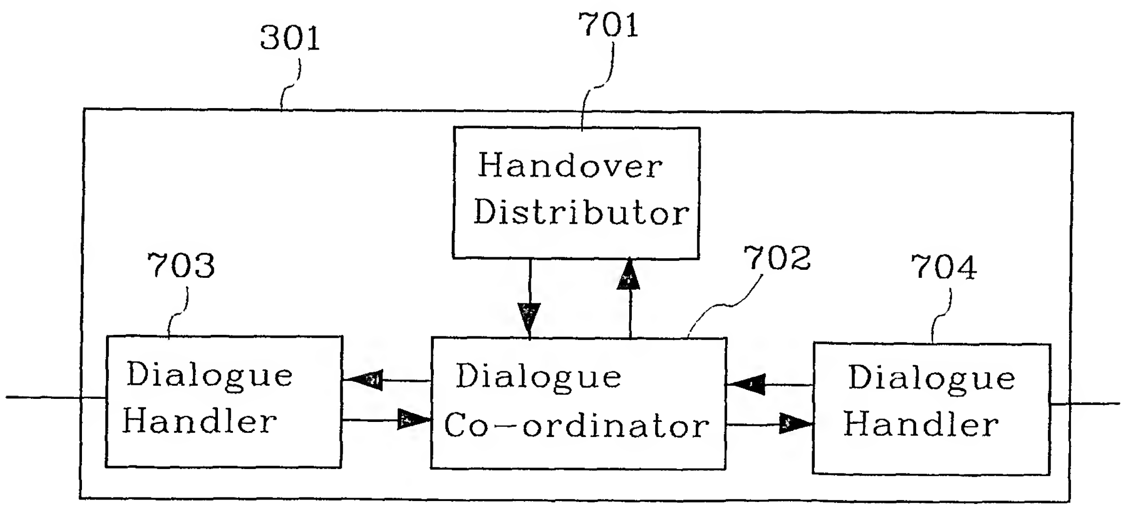

301
701
Handover Distributor
703
702
704
Dialogue Handler
Dialogue Co-ordinator
Dialogue Handler

Fig. 7

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 01/02179

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: H04Q 7/38
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: H04Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0982961 A2 (NEC CORPORATION), 1 March 2000 (01.03.00), column 6, line 41 - line 50; column 9, line 41 - column 10, line 3, figure 1, abstract --	1-20
A	EP 0898438 A2 (NOKIA MOBILE PHONES LTD), 24 February 1999 (24.02.99), figure 8, abstract --	1-20
A	US 6011971 A (JOLMA), 4 January 2000 (04.01.00), abstract --	1-20

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
17 January 2002	30-01-2002

Name and mailing address of the ISA/	Authorized officer
Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Stefan Hansson/js Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 01/02179

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5920817 A (UMEDA ET AL), 6 July 1999 (06.07.99), figure 2, abstract	1-20

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/SE 01/02179

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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		JP 2974019 B	08/11/99
		JP 2000069532 A	03/03/00
EP 0898438 A2	24/02/99	AU 7045198 A	08/03/99
		BR 9811247 A	18/07/00
		CN 1267440 T	20/09/00
		FI 105993 B	00/00/00
		FI 973425 A	21/02/99
		FI 990988 A	30/04/99
		HU 0002814 A	29/01/01
		JP 11113071 A	23/04/99
		WO 9909774 A	25/02/99
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		AU 2888695 A	09/02/96
		CN 1072435 B	03/10/01
		CN 1132015 A	25/09/96
		EP 0717914 A	26/06/96
		FI 98976 B,C	30/05/97
		FI 943303 A	12/01/96
		JP 10507040 T	07/07/98
		NO 960981 A	08/05/96
		WO 9602117 A	25/01/96
US 5920817 A	06/07/99	EP 0710425 A	08/05/96
		JP 9508773 T	02/09/97
		CN 1129054 A	14/08/96
		CN 1283945 A	14/02/01
		CN 1283946 A	14/02/01
		CN 1283947 A	14/02/01
		WO 9532594 A	30/11/95